GE Nuclear Energy

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AN EVALUATION TO DETERMINE THE LIMITING OPERATING CONDITION IN THE BFN III RPV FLAW HANDBOOK

November 1995

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1.0 INTRODUCTION & BACKGROUND

Reference 1 documented a structural flaw evaluation for Browns Ferry Unit III (BFN III) in accordance with ASME Code Section XI (1986 edition) for all axial (meridional or longitudinal) and circumferential welds in the vessel shell, top head, bottom head, and flange regions. The analysis assumed the most limiting loadings for normal (Level A), Upset (Level B), Emergency (Level C) and Faulted (Level D) operation. This analysis also stated that, "Previous analyses have shown hydrotest and boltup conditions, which involve the combination of low operating temperatures and high safety factors, to be the most limiting operating conditions for vessel welds. Hydrotest conditions and boltup conditions (flange regions) were therefore considered for fracture analysis." The objective of this report is to provide documentation supporting the preceding statement.

The approach used in this evaluation was to first determine a flaw that was allowable by the handbook based on hydrotest condition. This means, the applied K_I is equal to the allowable K_{ia} for hydrotest condition for this flaw geometry. In other words, the ratio of the applied K_I to the allowable K_{Ia} for the hydrotest condition is 1.0 for this flaw geometry. The applied K_I and allowable K_{Ia} calculations for the same flaw geometry were then conducted for the Level A,B,C and D conditions and similar ratios were calculated. If this ratio is greater than 1.0 for other operating conditions, then it will clearly show that the hydrotest condition was governing in the determination of allowable flaw sizes.

2.0 FRACTURE MECHANICS EVALUATION

The evaluation was conducted for H12 circumferential weld (see Figure 1). A circumferential flaw is postulated along the length of the weld. The allowable inside surface flaw sizes for this case are graphically shown in Figure 3-17 of Reference 1 (included here as Figure 2). The solid line for circumferentially oriented flaws per IWB-3600 evaluation is of interest for this case.

Now, consider a flaw with an aspect ratio of 1:6 or 0.166. This aspect ratio was chosen because this is the typical aspect ratio used in the RPV fracture mechanics evaluations. The stress intensity factor values for the limiting transients of Level C and D operating conditions for this geometry were obtained from Reference 2. The allowable flaw depth per Figure 2 is approximately 0.8 inch. Figure 3.0 shows the calculated and allowable values of stress intensity factors for various crack depths and aspect ratios. The allowable K values in the last column are based on the hydrotest temperature of 185°F. The adjusted reference temperature (ART) varies as a function of crack depth because the variation in the fluence value. Thus, based on the hydrotest condition, the values are the following:

Allowable crack depth:	0.8 inch (aspect ratio, 1:6)
K_I applied = K_I allowed:	Approx. 33 ksi√in.

The K_I applied was calculated using the hydrotest pressure value of 1100 psi which is 1.1 times the nominal operating pressure of 1000 psi. The safety factor used was √10 or 3.162.

2.1 Level A (Normal) Condition Evaluation

For this operating condition, the additional loading is the contribution from the 100°F/hour rate during startup and shutdown. The K_I from this loading is positive at the inside surface during shutdown. The stress intensity factor K_{It} was calculated using the following expression from Reference 3:

$$K_{It} = [(CR)/1000]\, t^{2.5} F_3$$

where

CR = Cooling rate in °F/hr
t = Vessel thickness
F_3 = $0.690 + 3.127\,(a/t) - 7.435\,(a/t)^2 + 3.532\,(a/t)^3$

Using a cooling rate of 100°F/hr, thickness of 6.125 inches, and a=0.8 inch, gave a K_{It} of 9.1 ksi√in. Thus, K_I applied during the Level A condition is conservatively estimated as (33.0+9.1) or 42.1 ksi√in. This value is conservative because the internal pressure assumed in arriving at 33 ksi√in value was 1100 psi (corresponding to the hydrotest pressure versus the operating pressure of 1000 psi during Level A condition).

The temperature at the start of shutdown (when the pressure is highest) is such that the K_{ia} value is 200 ksi√in. This gives an allowable K_I value of (200/3.162) or 63.2 ksi√in. This value is considerably larger than the applied value of K_I. The ratio of allowable K_{ia} to applied K_I for this condition is then (63.2/42.1) or 1.5.

2.2 Level B (Upset) Condition Evaluation

All of the thermal transients during the upset condition involve cooling rates less than 100°F/hr. This case was already covered in Level A condition evaluation. The only other loading is the seismic. A review of Reference 4 indicated the maximum OBE moment to be 8583 kip-ft. This gave a nominal OBE seismic bending stress of 324 psi. A 29 psi increase in the internal pressure would produce the same magnitude of membrane stress in the RPV. Since, the evaluation for Level A already considered a 1100 psi internal pressure versus a normal operating pressure of 1000 psi, the applied K_I of 42.1 ksi√in calculated for Level A condition is also a bounding number for Level B conditions including the seismic. The allowable K_{Ia} for level B conditions is the same as that for Level A conditions. Thus, the ratio of allowable K_{Ia} to applied K_I for this condition is also 1.5.

2.3 Level C (Emergency) Condition Evaluation

The thermal cycle chart for the BFN III [Reference 5] does not classify various thermal transients into Level C and D categories. Nevertheless, as was discussed in Reference 2, the Improper Start of Recirculation Loop transient is the limiting Level C transient for this plant. Figure 4 shows the pressure temperature conditions during the transient. Figure 5 shows the plot of calculated values of K for a 1:6 aspect ratio flaw. The vessel geometry used in this evaluation was very similar to the BFN III vessel. Table 1 from Reference 2 shows the calculated values of K for various loadings as a function of crack depth. The K values in the first row of the circumferential flaw case are relevant for this evaluation. The K_t and K_{clad} are 26.5 and 2.0 ksi√in, respectively. For the pressure loading, the K value calculated for the hydrotest case (@ 1100 psi) can be conservatively used. The applied total K for Level C condition can then be calculated as:

$$
\begin{aligned}
K_{total} &= K_p + K_t + K_{clad} \\
&= 33.0 + 26.5 + 2.0 \\
&= 61.5 \text{ ksi}\sqrt{\text{in}}.
\end{aligned}
$$

Since the temperature during this transient is high enough, the K_{Ia} value is 200 ksi√in. The safety factor for the Level C condition is √2 or 1.414. Therefore, the allowable value of K_{ia} is 200/1.414 or 141.4 ksi√in. As can be seen, this value considerably exceed the applied value of 61.5 ksi√in. The ratio of allowable K_{ia} to applied K_I for this condition is then (141.4/61.5) or 2.3.

2.4 Level D (Faulted) Condition Evaluation

The transient used for Level D condition evaluation was the Loss of Coolant Accident (LOCA) Event as shown in Figure 6. Figure 7 shows the calculated values of K as a function of crack depth for a 1:6 aspect ratio flaw. Table 2 shows the calculated values of K total as a function of crack depth. The values in the first row of this table (a=0.81 inch) are relevant for this evaluation. As can be seen in this table, the dominant contribution to total K essentially comes from the thermal K. The K_{total} is shown as 62.8 ksi$\sqrt{in}$.

The safety factor for the Level D condition is also $\sqrt{2}$ or 1.414. Therefore, the allowable value of K_{Ia} for Level D conditions is (200/1.414) or 141.4 ksi$\sqrt{in}$. Once again, the applied K value is significantly lower than the allowable value of K. The ratio of allowable K_{Ia} to applied K_I for this condition is then (141.4/62.8) or 2.2.

3.0 SUMMARY AND CONCLUSIONS

In developing the allowable flaw sizes reported in the RPV Flaw Evaluation Handbook for BFN III, hydrotest and boltup conditions, which involve the combination of low operating temperatures and high safety factors, were found to be the most limiting operating conditions for vessel welds. The objective of this report is to provide documentation supporting the preceding statement.

For the purpose of this evaluation, a circumferentially oriented flaw with an aspect ratio of 1:6 at the weld between shell courses 1 and 2 (H12 weld) was selected. The allowable flaw depth reported in the flaw handbook based on the hydrotest condition as limiting, was 0.8 inch. Essentially, the applied K_I value for this flaw geometry was equal to the hydrotest condition allowable K_{Ia} value. The applied and allowable K_{Ia} values for the same flaw geometry were then calculated and are summarized in the table below:

Operating Condition	Applied K_I (ksi√in)	Allowable K_{ia} (ksi√in)	K_I Ratio, Allowable/ Applied
Hydrotest	33.0	33.0	1.0
Level A	42.1	63.2	1.5
Level B	42.1	63.2	1.5
Level C	61.5	141.4	2.3
Level D	62.8	141.4	2.2

The Table above clearly shows that the allowable flaw depth based on the hydrotest condition is governing. The applied K_I values for other operating conditions for the same flaw geometry are considerably less than the allowable values. This means, the allowable flaw depth based on other operating conditions such as Level A/B/C/D would have been higher than that based on the hydrotest condition.

4.0 REFERENCES

[1] "Browns Ferry Unit III Flaw Evaluation Handbook," GE Report No. GENE-523-120-0992, Rev. 0, September 1992.

[2] Mehta, H.S., T.A. Caine and S.E. Plaxton, "10CFR50 Appendix G Equivalent Margin Analysis for Low Upper Shelf Energy in BWR/2 Through /6 Vessels," GE Report No. NEDO-32205-A, Class I, Rev. 1, February 1994.

[3] ASME Code Case N-512, "Assessment of Reactor Vessels with Low Upper Shelf Charpy Impact Energy Levels," Approved February 12, 1993.

[4] TVA Calculation No. CD-Q2302-894251, "Recalculation of Seismic Responses for Reactor Building Drywell and Internals of Browns ferry Nuclear power Plant Using El Centro Time History Input," August 7, 1989.

[5] GE Drawing No. 729E762, Rev. 0.

Table 1
Applied K and J-Integral Values for BWR/3-6 Case for Level C Limiting Transient

EMERGENCY CONDITION EVENT 24		Kt FIT COEFFICIENTS		CLAD STRESS	
PRESSURE(PSI)=	1050	a=	8.831288		
VESSEL Ri (IN)=	126.7	b=	74.92595	S (KSI)=	6
VESSEL TH (IN)=	6.19	c=	-107.681		
CLAD THICKNESS=	0.19	d=	63.6289		
a0 (IN)=	0.809	e=	-14.3416		
E(KSI)=	27700				
YS (KSI)=	69				

AXIAL FLAW

a	F1	Kt	Kp	K,clad	ae	F1'	Kt'	Kp'	K',clad	Ktotal	Japp
0.81	1.00	26.52	35.91	1.98	0.86	1.00	26.28	36.99	1.92	65.19	139.62
0.86	1.00	26.26	37.08	1.91	0.91	1.00	25.98	38.18	1.86	66.01	143.15
0.91	1.00	25.96	38.23	1.85	0.96	1.01	25.65	39.34	1.80	66.79	146.54
0.96	1.01	25.64	39.37	1.80	1.01	1.01	25.30	40.48	1.75	67.53	149.82
1.01	1.01	25.30	40.48	1.75	1.06	1.01	24.96	41.60	1.70	68.25	153.02
1.06	1.01	24.95	41.59	1.70	1.11	1.01	24.57	42.72	1.66	68.94	156.16
1.11	1.01	24.58	42.68	1.66	1.16	1.02	24.19	43.82	1.62	69.62	159.25
1.16	1.02	24.21	43.76	1.62	1.21	1.02	23.79	44.91	1.58	70.29	162.29
1.21	1.02	23.82	44.83	1.58	1.26	1.02	23.39	46.00	1.55	70.93	165.27
1.26	1.02	23.43	45.89	1.55	1.31	1.03	22.96	47.07	1.51	71.54	168.15
1.31	1.03	23.01	46.95	1.52	1.37	1.03	22.50	48.16	1.48	72.13	170.91
1.36	1.03	22.57	48.00	1.49	1.42	1.03	22.01	49.21	1.45	72.67	173.49
1.41	1.03	22.09	49.04	1.46	1.47	1.04	21.46	50.27	1.43	73.16	175.83
1.46	1.04	21.56	50.09	1.43	1.52	1.04	20.85	51.33	1.40	73.58	177.86
1.51	1.04	20.97	51.13	1.41	1.57	1.05	20.15	52.39	1.38	73.92	179.50
1.56	1.05	20.30	52.17	1.38	1.62	1.05	19.36	53.44	1.35	74.15	180.64
1.61	1.05	19.54	53.21	1.36	1.67	1.06	18.44	54.49	1.33	74.26	181.18
1.66	1.05	18.66	54.25	1.34	1.72	1.06	17.38	55.54	1.31	74.23	181.02
1.71	1.06	17.64	55.30	1.32	1.77	1.06	16.16	56.58	1.29	74.03	180.05
1.76	1.06	16.45	56.34	1.30	1.82	1.07	14.74	57.62	1.27	73.64	178.15
1.81	1.07	15.08	57.39	1.28	1.87	1.07	13.12	58.66	1.26	73.03	175.22

WORKSHEET: BWROGUS2.WK1

CIRCUMFERENTIAL FLAW

a	F1	Kt	Kp	K,clad	ae	F1'	Kt'	Kp'	K',clad	Ktotal	Japp
0.81	0.92	26.52	17.33	1.98	0.83	0.92	26.40	17.60	1.95	45.95	69.36
0.86	0.92	26.26	17.90	1.91	0.88	0.93	26.12	18.17	1.88	46.18	70.06
0.91	0.93	25.96	18.47	1.85	0.93	0.93	25.81	18.74	1.83	46.38	70.66
0.96	0.93	25.64	19.03	1.80	0.98	0.93	25.48	19.29	1.77	46.55	71.18
1.01	0.93	25.30	19.58	1.75	1.03	0.93	25.13	19.84	1.73	46.70	71.64
1.06	0.93	24.95	20.12	1.70	1.08	0.94	24.77	20.38	1.69	46.83	72.04
1.11	0.94	24.58	20.65	1.66	1.13	0.96	24.40	20.91	1.64	46.95	72.41
1.16	0.94	24.21	21.17	1.62	1.18	0.94	24.02	21.43	1.60	47.05	72.74
1.21	0.94	23.82	21.69	1.58	1.23	0.95	23.63	21.95	1.57	47.14	73.02
1.26	0.95	23.43	22.21	1.55	1.28	0.95	23.22	22.46	1.53	47.22	73.24
1.31	0.95	23.01	22.72	1.52	1.33	0.95	22.79	22.97	1.50	47.26	73.39
1.36	0.95	22.57	23.22	1.49	1.38	0.95	22.33	23.47	1.47	47.28	73.43
1.41	0.96	22.09	23.72	1.46	1.43	0.96	21.83	23.97	1.45	47.25	73.34
1.46	0.96	21.56	24.22	1.43	1.48	0.96	21.27	24.47	1.42	47.16	73.07
1.51	0.96	20.97	24.72	1.41	1.53	0.96	20.65	24.96	1.39	47.00	72.58
1.56	0.97	20.30	25.21	1.38	1.58	0.97	19.94	25.45	1.37	46.76	71.83
1.61	0.97	19.54	25.70	1.36	1.63	0.97	19.13	25.93	1.35	46.41	70.75
1.66	0.97	18.66	26.18	1.34	1.68	0.97	18.19	26.41	1.33	45.93	69.31
1.71	0.98	17.64	26.67	1.32	1.73	0.98	17.11	26.89	1.31	45.31	67.44
1.76	0.98	16.45	27.15	1.30	1.78	0.98	15.86	27.37	1.29	44.52	65.10
1.81	0.98	15.08	27.63	1.28	1.83	0.98	14.42	27.84	1.27	43.53	62.24

Table 2
Applied K and J-Integral Values for BWR/3-6 Case for Level D Limiting Transient

FAULTED CONDITION EVENT 27		Kt FIT COEFFICIENTS		CLAD STRESS	
PRESSURE(PSI)=	20				
VESSEL Ri (IN)=	126.7	a=	14.00964		
VESSEL TH (IN)=	6.19	b=	130.9087	S (KSI)=	16.5
CLAD THICKNESS=	0.19	c=	-155.726		
a0 (IN)=	0.809	d=	89.8447		
E(KSI)=	27700	e=	-20.6397		
YS (KSI)=	69				

AXIAL FLAW

a	F1	Kt	Kp	K,clad	ae	F1'	Kt'	Kp'	K',clad	Ktotal	Japp
0.81	1.00	56.72	0.68	5.44	0.85	1.00	57.20	0.70	5.28	63.19	131.17
0.86	1.00	57.26	0.71	5.26	0.90	1.00	57.67	0.73	5.11	63.51	132.53
0.91	1.00	57.72	0.73	5.10	0.95	1.01	58.08	0.75	4.96	63.79	133.67
0.96	1.01	58.12	0.75	4.95	1.00	1.01	58.42	0.77	4.82	64.02	134.63
1.01	1.01	58.45	0.77	4.81	1.05	1.01	58.72	0.79	4.69	64.20	135.42
1.06	1.01	58.74	0.79	4.68	1.10	1.01	58.97	0.81	4.58	64.35	136.06
1.11	1.01	58.99	0.81	4.57	1.16	1.02	59.17	0.83	4.47	64.47	136.53
1.16	1.02	59.18	0.83	4.46	1.21	1.02	59.32	0.85	4.36	64.54	136.83
1.21	1.02	59.33	0.85	4.36	1.26	1.02	59.42	0.87	4.27	64.56	136.93
1.26	1.02	59.42	0.87	4.26	1.31	1.03	59.45	0.89	4.18	64.53	136.78
1.31	1.03	59.45	0.89	4.17	1.36	1.03	59.41	0.91	4.10	64.42	136.34
1.36	1.03	59.41	0.91	4.09	1.41	1.03	59.28	0.93	4.02	64.23	135.55
1.41	1.03	59.27	0.93	4.01	1.45	1.04	59.05	0.95	3.94	63.94	134.33
1.46	1.04	59.02	0.95	3.94	1.50	1.04	58.69	0.97	3.87	63.53	132.60
1.51	1.04	58.65	0.97	3.87	1.55	1.05	58.18	0.99	3.81	62.98	130.29
1.56	1.05	58.11	0.99	3.80	1.60	1.05	57.49	1.01	3.74	62.25	127.31
1.61	1.05	57.40	1.01	3.74	1.65	1.05	56.61	1.03	3.69	61.33	123.57
1.66	1.05	56.47	1.03	3.68	1.70	1.06	55.51	1.05	3.63	60.19	119.01
1.71	1.06	55.30	1.05	3.62	1.75	1.06	54.15	1.07	3.58	58.79	113.56
1.76	1.06	53.84	1.07	3.56	1.80	1.07	52.51	1.09	3.52	57.12	107.19
1.81	1.07	52.05	1.09	3.51	1.84	1.07	50.55	1.11	3.48	55.14	99.87

WORKSHEET: BWROGUS2.WK1

CIRCUMFERENTIAL FLAW

a	F1	Kt	Kp	K,clad	ae	F1'	Kt'	Kp'	K',clad	Ktotal	Japp
0.81	0.92	56.72	0.33	5.44	0.85	0.92	57.20	0.34	5.28	62.82	129.65
0.86	0.92	57.26	0.34	5.26	0.90	0.93	57.67	0.35	5.12	63.14	130.96
0.91	0.93	57.72	0.35	5.10	0.95	0.93	58.07	0.36	4.96	63.40	132.05
0.96	0.93	58.12	0.36	4.95	1.00	0.93	58.42	0.37	4.82	63.62	132.96
1.01	0.93	58.45	0.37	4.81	1.05	0.93	58.72	0.38	4.70	63.79	133.70
1.06	0.93	58.74	0.38	4.68	1.10	0.94	58.96	0.39	4.58	63.93	134.29
1.11	0.94	58.99	0.39	4.57	1.15	0.94	59.17	0.40	4.47	64.04	134.71
1.16	0.94	59.18	0.40	4.46	1.20	0.94	59.32	0.41	4.37	64.10	134.97
1.21	0.94	59.33	0.41	4.36	1.25	0.95	59.42	0.42	4.27	64.11	135.02
1.26	0.95	59.42	0.42	4.26	1.30	0.95	59.45	0.43	4.18	64.07	134.84
1.31	0.95	59.45	0.43	4.17	1.35	0.95	59.41	0.44	4.10	63.95	134.36
1.36	0.95	59.41	0.44	4.09	1.40	0.96	59.29	0.45	4.02	63.76	133.54
1.41	0.96	59.27	0.45	4.01	1.45	0.96	59.05	0.46	3.94	63.46	132.29
1.46	0.96	59.02	0.46	3.94	1.50	0.96	58.69	0.47	3.87	63.04	130.54
1.51	0.96	58.65	0.47	3.87	1.55	0.97	58.18	0.48	3.81	62.47	128.21
1.56	0.97	58.11	0.48	3.80	1.60	0.97	57.51	0.49	3.75	61.74	125.22
1.61	0.97	57.40	0.49	3.74	1.65	0.97	56.63	0.50	3.69	60.81	121.49
1.66	0.97	18.66	0.50	3.68	1.66	0.97	56.35	0.50	3.67	60.52	120.32
1.71	0.98	17.64	0.51	3.62	1.71	0.98	55.16	0.51	3.61	59.28	115.44
1.76	0.98	16.45	0.52	3.56	1.76	0.98	53.68	0.52	3.56	57.76	109.60
1.81	0.98	15.08	0.53	3.51	1.81	0.98	51.89	0.53	3.51	55.93	102.75

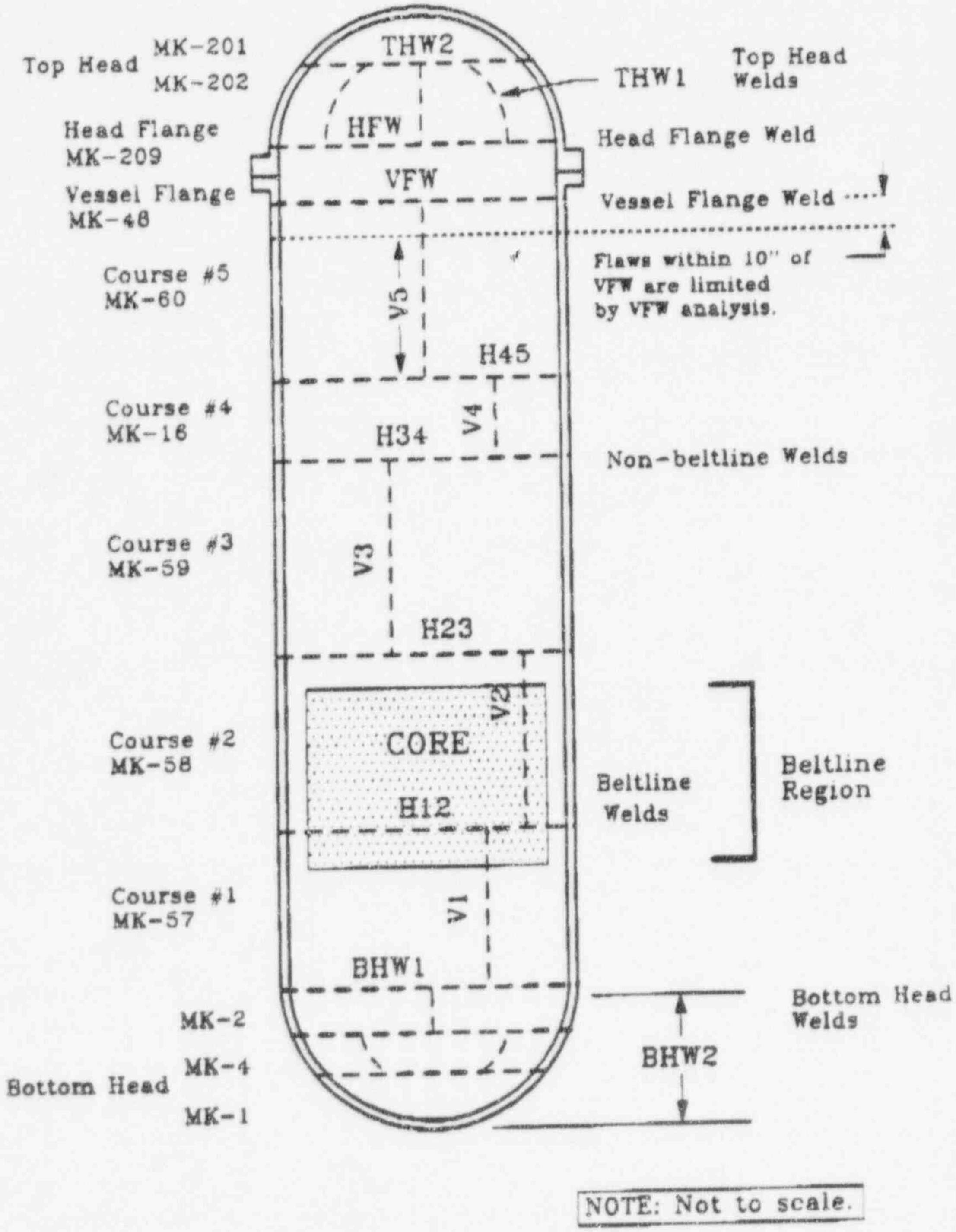

Figure 1 Weld Regions for BFN III RPV Flaw Evaluation

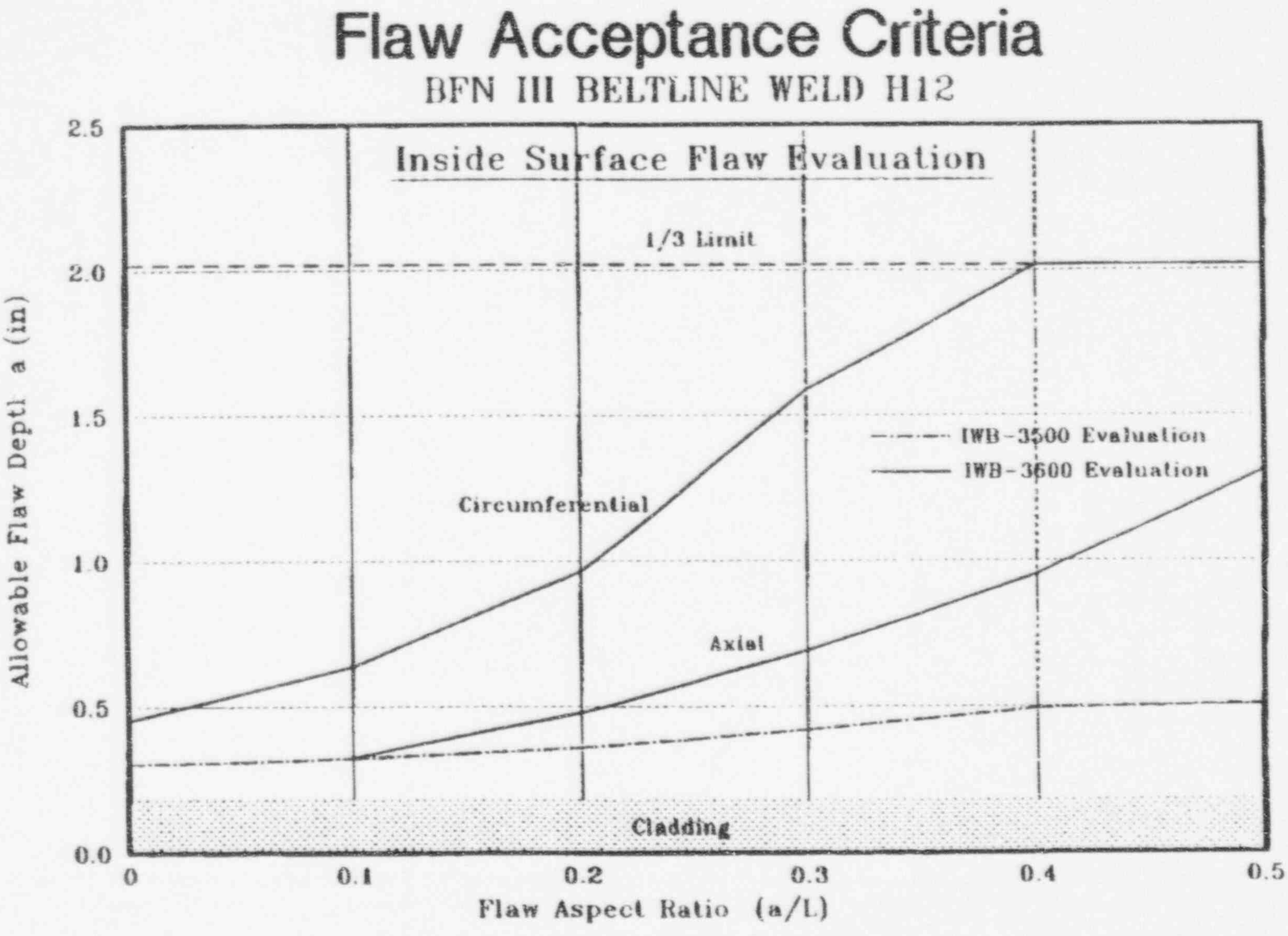

Figure 2 Allowable Surface Flaw Sizes for Horizontal Beltline Weld

Figure 3 Applied K values for Surface Circumferential Flaw at H12 Weld

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*******************************************************
*** BELTLINE FLAW EVALUATION ANALYSIS PROGRAM      ***
***        "BELTFLAW", REVISION 0 [KPD]            ***
***    DRF 137-0010-5       GE-NE-523-123-0992     ***
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BFN3 H12 CIRCUM SURFACE

9/22/1992 - 17:53:13

*** FLAW EVALUATION SUMMARY ***

```
EFPY                 =  12.000 (yrs)
CLAD THICKNESS       =    .188 (in)
LAS WALL THICKNESS   =   6.125 (in)
MEMBRANE  STRESS     =  11.300 (ksi)
BENDING   STRESS     =   8.000 (ksi)
CLAD RES. STRESS     =  24.000 (ksi)
YIELD STRENGTH       =  47.000 (ksi)
SERVICE TEMPERATURE = 185.000 (F)
INITIAL RTndt        =  10.000 (F)
CHEMISTRY FACTOR     = 105.600
FACTOR OF SAFETY     =   3.162
```

Applied Stress Intensity (ksi-sqr[in])

a/t	a (in)	a/l=0.0	0.1	0.2	0.3	0.4	0.5	ART	K_IA	Allow
.04	.25	28.24	26.38	23.92	21.46	19.16	17.18	62.9	100.45	31.76
.06	.38	30.33	28.12	25.36	22.71	20.27	18.16	62.0	101.41	32.07
.08	.50	33.02	30.32	27.19	24.31	21.69	19.41	61.1	102.38	32.38
.10	.63	35.84	32.54	29.00	25.89	23.07	20.64	60.3	103.35	32.68
.12	.76	38.74	34.69	30.73	27.37	24.37	21.77	59.4	104.32	32.99
.14	.88	41.71	36.77	32.36	28.75	25.55	22.82	58.5	105.28	33.29
.16	1.01	44.80	38.81	33.90	30.03	26.64	23.78	57.7	106.25	33.60
.18	1.14	48.04	40.81	35.37	31.23	27.64	24.65	56.9	107.22	33.91
.20	1.26	51.45	42.80	36.78	32.35	28.56	25.45	56.0	108.18	34.21
.22	1.39	55.07	44.81	38.15	33.40	29.40	26.18	55.2	109.15	34.51
.24	1.51	58.94	46.84	39.49	34.40	30.17	26.84	54.4	110.11	34.82
.26	1.64	63.09	48.91	40.80	35.35	30.87	27.45	53.6	111.07	35.12
.28	1.77	67.55	51.06	42.10	36.25	31.52	28.00	52.9	112.03	35.43
.30	1.89	72.37	53.28	43.40	37.11	32.11	28.50	52.1	112.98	35.73
.32	2.02	77.58	55.61	44.71	37.94	32.65	28.95	51.3	113.94	36.03
.34	2.15	83.22	58.06	46.02	38.74	33.14	29.36	50.6	114.89	36.33
.36	2.27	89.33	60.63	47.36	39.51	33.58	29.73	49.8	115.83	36.63
.38	2.40	95.96	63.36	48.72	40.26	33.98	30.05	49.1	116.78	36.93
.40	2.53	103.16	66.26	50.12	40.99	34.34	30.35	48.4	117.72	37.23
.42	2.65	110.96	69.34	51.57	41.71	34.66	30.60	47.7	118.65	37.52
.44	2.78	119.43	72.62	53.06	42.41	34.95	30.83	47.0	119.59	37.82
.46	2.90	128.62	76.13	54.60	43.11	35.21	31.02	46.3	120.52	38.11
.48	3.03	138.59	79.86	56.21	43.80	35.43	31.19	45.6	121.44	38.40
.50	3.16	149.39	83.85	57.88	44.48	35.63	31.33	45.0	122.36	38.69

EVENT 24
Emergency Condition

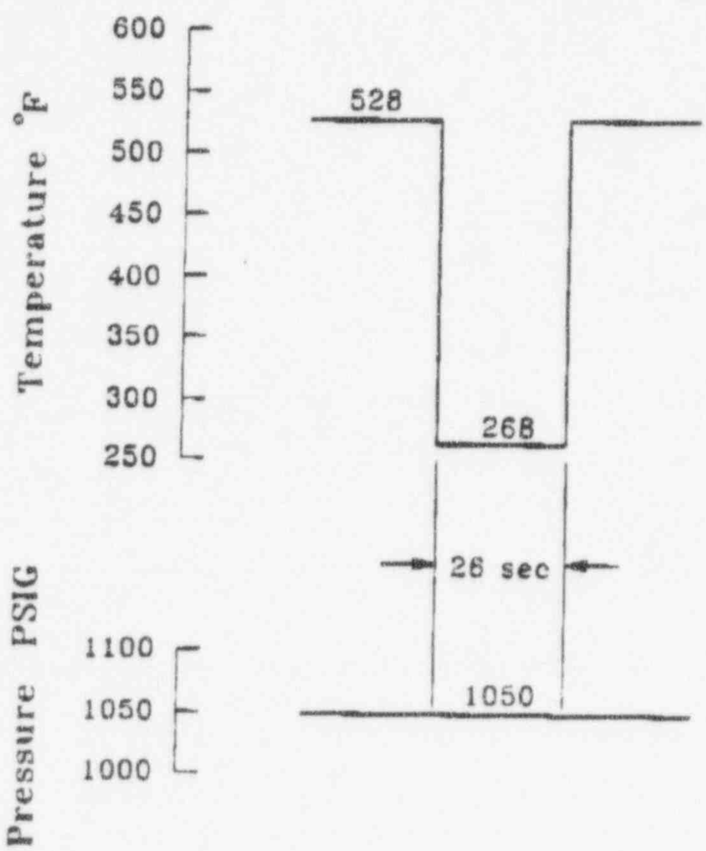

Figure 4 Pressure and Temperature Conditions During Improper Start of Cold Recirculation Loop Transient

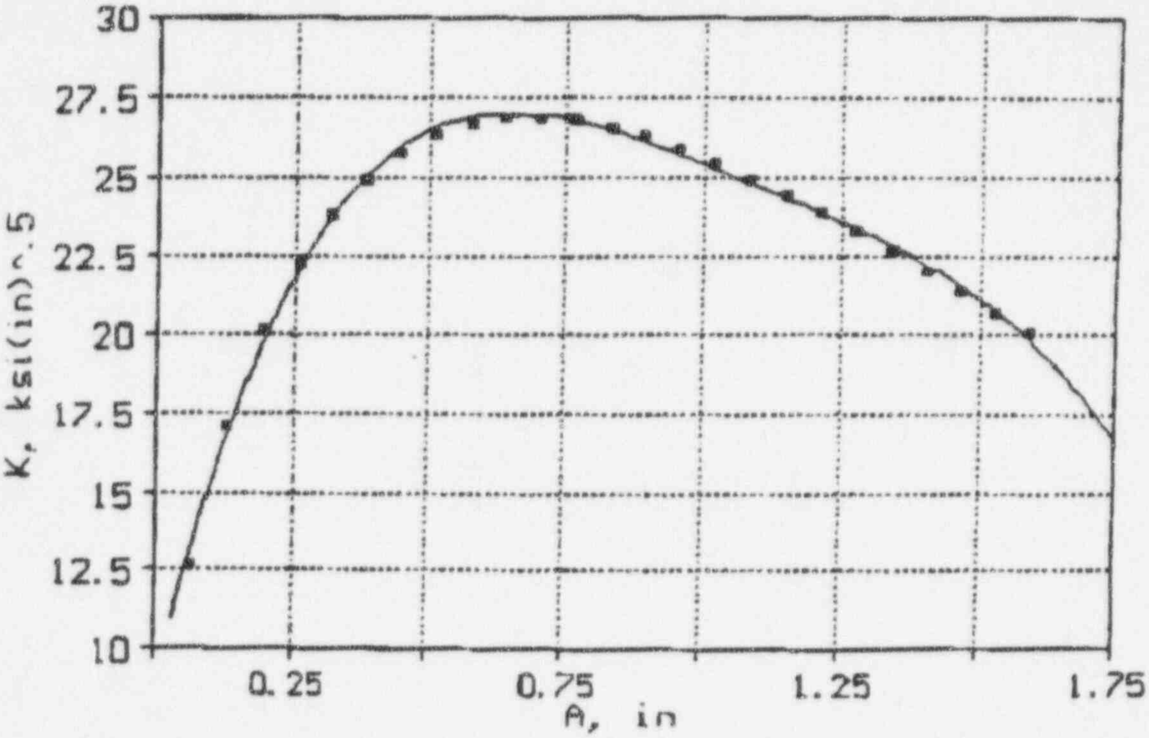

Figure 5 Calculated K values for Level C Transient in Figure 4 (1:6 Flaw)

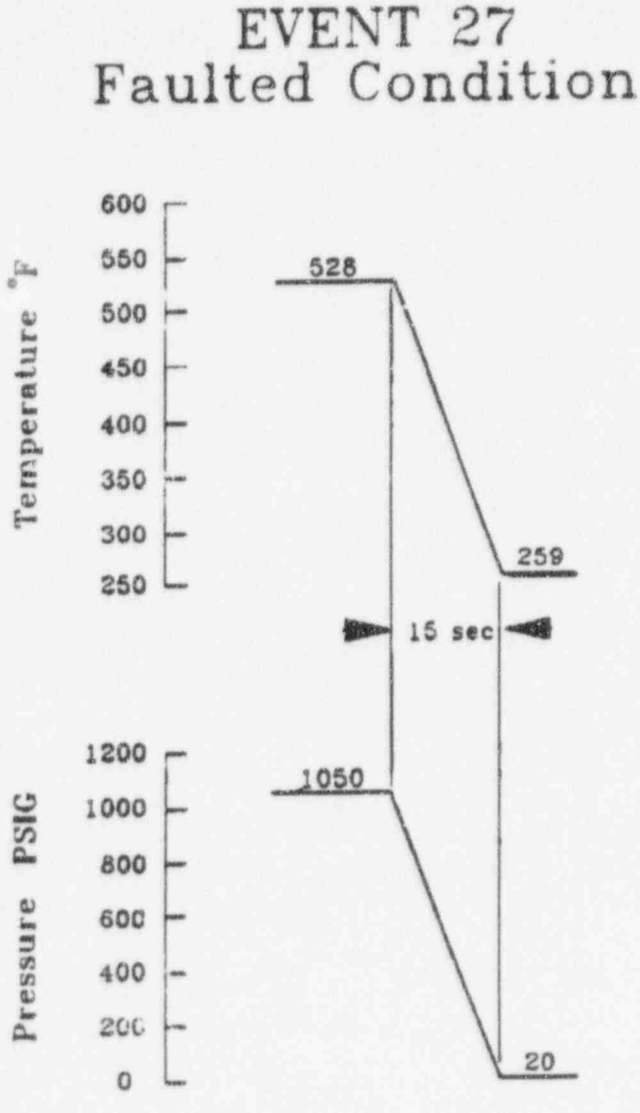

Figure 6 Limiting Level D Transient (LOCA)

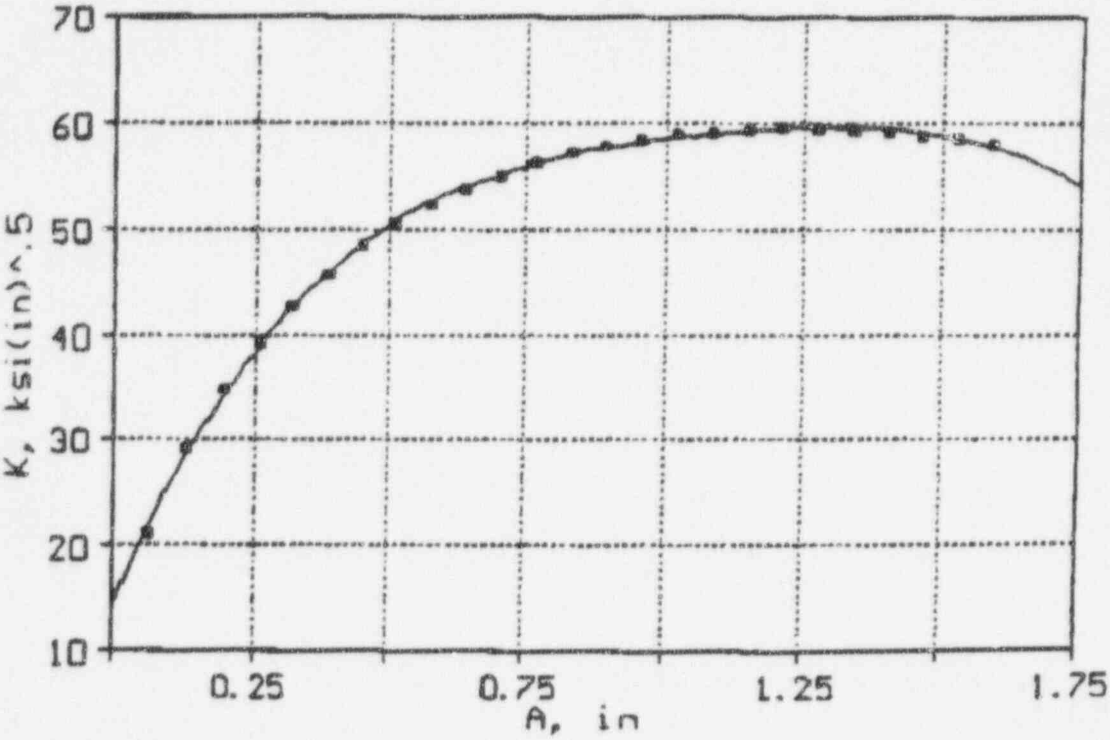

Figure 7 Calculated K values for Level D Transient in Figure 6 (1:6 Flaw)